AEDC-TDR-63-75

RADIATION TRANSMISSION THROUGH SHIELDING ARRAYS FOR LOW TEMPERATURE PUMPING SURFACES

By
W. G. Kirby
Aerospace Environmental Facility
ARO, Inc.

TECHNICAL DOCUMENTARY REPORT NO. AEDC-TDR-63-75

May 1963

AFSC Program Area 850E, Project 7778, Task 777800

(Prepared under Contract No. AF 40(600)-1000 by ARO, Inc., contract operator of AEDC, Arnold Air Force Station, Tenn.)

ARNOLD ENGINEERING DEVELOPMENT CENTER

AIR FORCE SYSTEMS COMMAND

UNITED STATES AIR FORCE

NOTICES

Qualified requesters may obtain copies of this report from ASTIA. Orders will be expedited if placed through the librarian or other staff member designated to request and receive documents from ASTIA.

When Government drawings, specifications or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

RADIATION TRANSMISSION THROUGH SHIELDING ARRAYS FOR LOW TEMPERATURE PUMPING SURFACES

By

W. G. Kirby

Aerospace Environmental Facility

ARO, Inc.

a subsidiary of Sverdrup and Parcel, Inc.

May 1963

ARO Project No. SN2209

ABSTRACT

The results of an investigation to determine the amount of thermal radiation transmitted through two cryosurface configurations are presented. The configurations were composed of a 20°K cryosurface enclosed in a 77°K box with a test opening shielded by an optically dense array of 77°K cryosurfaces coated with Parson's black. Radiation at various levels of intensity was applied to the shielding array opening, and the heat load on the 20°K cryosurface imposed by energy transmitted through an array was measured. Heat transmission was also investigated with frost layers deposited over the Parson's black coating on the shielding surfaces.

PUBLICATION REVIEW

This report has been reviewed and publication is approved.

Jay D. Pinson
Capt, USAF
Chief, Experimental Division
Space Systems Office

Donald D. Carlson
Lt Col, USAF
Chief, Space Systems Office

CONTENTS

TABLES

ILLUSTRATIONS

NOMENCLATURE

E	Lamp efficiency
$\dot{m}$	Mass flow rate
N	Number of photons
Q	Heat load rate
R	Radiation transmission coefficient
s	Specific heat
T	Absolute temperature
W	Lamp total power input rate
ϵ	Emissivity of surface
σ	Boltzmann radiation constant

SUBSCRIPTS

1	Inlet or power level
2	Outlet or power level
a	Array surface
c	Calculated
I	Incident
n	Number of reflection
p	Pumping surface
T	Total
t	Transmitted

1.0 INTRODUCTION

In a space environmental chamber, the low temperature cryopumping surfaces (less than 25°K) must dissipate, in addition to the gas condensation heat load, the heat load from various radiation sources, such as the test vehicle and solar simulation systems. There is a need to reduce these radiation heat loads by shielding and, thereby, minimize the refrigeration requirements for the cryopumping surfaces. An investigation is being conducted at the Arnold Engineering Development Center (AEDC), Air Force Systems Command (AFSC), to determine the cryopumping and the transmitted radiation characteristics of several shielding configurations. The initial phase of this work was concerned with the cryopumping characteristics of two shielding arrays and was described in an earlier report (Ref. 1).

The present report is a continuation of the work on these two arrays. The amount of radiation transmitted through these shielding arrays to the cryopumping surface was measured experimentally.

2.0 APPARATUS

The experimental investigations of the radiant heat transmission through 77°K shielding surfaces to helium-cooled pumping surfaces were conducted in the 7-Ft Aerospace Research Chamber of the Aerospace Environmental Facility (AEF), AEDC. This chamber is described in detail in Ref. 1.

2.1 SHIELDING ARRAY CONFIGURATIONS

The shielding cryosurfaces and pumping cryosurfaces were housed in a liquid-nitrogen-cooled box approximately 48 in. wide by 48 in. long by 33 in. deep. A radiation path to the pumping cryosurface was provided by an opening, 44 by 44 in., in one side of the box. The shielding cryoarray was installed in this opening. The sides of the box were fitted together closely and bolted to avoid any radiation leakage to the pumping surface.

The pumping surfaces were suspended from the liquid-nitrogen-cooled box by four springs to minimize heat conduction loads to these surfaces through the mounting supports. The front edges of all pumping

Manuscript received March 1963.

surfaces were located 18 in. from the front of the box. The shielding surfaces were mounted in the box in the same plane with the front edge of the opening of the box. Hydrogen vapor pressure thermometers were installed in the inlet and outlet gaseous helium lines to the pumping surfaces. These thermometers were located behind the pumping surface within the liquid-nitrogen-cooled box. Calibrated copper-constantan thermocouples were installed in the same relative positions on the shielding arrays.

The box, shielding and pumping surfaces were constructed of tube sheet panels fabricated from 1100 alloy aluminum by the Reynolds Metal Company. The shielding surfaces were coated with Parson's black prior to testing. The pumping surfaces were uncoated and were tested as fabricated. The box surface had the commercial finish for the full chevron array but was coated with Parson's black on the internal surface for the half chevron.

The geometry of the cryosurfaces and the test installation can be more adequately described by a schematic drawing because of the complexity of the arrays. Schematic drawings are presented in the following figures to describe the test configurations that were covered in this investigation:

Fig. 1 Full Chevron-Flat Plate Array with Blackbody Heater

Fig. 2 Full Chevron-Flat Plate Array with Osram-Xenon Lamp

Fig. 3 Half Chevron-Flat Plate Array with Blackbody Heater

Fig. 4 Half Chevron-Flat Plate Array with Osram-Xenon Lamp

2.2 PRESSURE MEASUREMENTS

The vacuum chamber pressure measurements were made with calibrated Bayard-Alpert-type ionization gages. These gages were used to measure the pressures in front of the 20°K pumping surface and the shielding array.

The gages were calibrated by the Engineering Support Facility, AEDC, for nitrogen gas from 10^{-3} to 10^{-6} torr. For pressures below 10^{-6} torr, extrapolated values were obtained by assuming that the gage factor remained constant for lower pressures.

2.3 RADIATION HEATERS

The heat sources for these tests were a heated aluminum plate and an Osram-Xenon lamp. The Osram-Xenon lamp was used to extend the test wavelength spectrum in the direction of the shorter wavelength and to determine if there was any measurable effect of wavelength on the transmission of heat through the shielding surfaces.

Typical spectral intensity versus wavelength curves for the maximum and minimum temperatures used in the experimental runs were calculated by Planck's Law and are presented in Fig. 5 for the blackbody heater. A similar spectral intensity curve for the Osram-Xenon lamp, as determined experimentally at AEDC (Ref. 2), is presented in Fig. 6. The wavelength band for the Osram lamp is from 0. 1 to approximately 2 microns. The blackbody heater covers the wavelength band from approximately 1. 5 to 70 microns.

A common housing was used for both units. The housing was a rectangular aluminum box 48 x 48 x 7 in. lined with highly reflective aluminum foil. The housing was bolted directly to the cryoarray shielding box for the plate heater installation. However, in the case of the Osram-Xenon lamp, the housing was spaced so that there was an 8-in. gap between the source housing and shielding box. The high voltage leads for the Osram-Xenon lamp were brought through this opening and were positioned to prevent arcing during operation of the lamp.

The aluminum plate heater, or blackbody heater as it is referred to in later discussion, was 44 x 44 x 1/8 in. and was positioned 2 in. away from and parallel to the entrance plane of the test array. The side of the heater facing the array was covered with lampblack, and the opposite side was commercially smooth aluminum surface. Nine 250-watt strip heaters were used to heat the plate. Thermocouples were located across the radiating face to measure the average temperature of the plate.

The Osram-Xenon lamp was positioned in the center of the housing box and was located approximately 10 in. in front of the entrance plane of the array. Provisions were made to measure the wattage input to the lamp. An efficiency curve for the lamp is shown in Fig. 7 (Ref. 2).

2.4 PUMPING SURFACE HEAT LOAD MEASURING SYSTEM

The rate of transmission of radiant energy to the 20°K cryosurface was determined from the rate at which heat was transferred to helium gas cooling the cryosurface. A diagram of the helium flow system is shown in Fig. 8. The heat transmission rate is calculated from the following measurable quantities: (1) the mass rate of flow through the pumping surface, and (2) the temperature of the helium gas at the inlet and outlet to the surface, or the corresponding temperature differential. The pumping surface heat load in terms of these values can be expressed as follows:

$$\text{Cryosurface Heat Load} = Q_c = \dot{m}s\ (T_2 - T_1)$$

where

$\dot{m}$ = mass flow rate of H_e

s = specific heat of H_e

T_2, T_1 = absolute temperature at inlet and outlet of pumping surface

For the steady-state operation of the helium refrigeration system, the major portion of the flow from the system goes through a cryosurface bypass orifice and returns to the inlet of the refrigeration compressor. The flow through the pumping surface is bled off from the main refrigeration stream by means of the control valves in the rotameter section. After passage through the cryosurface, the cold helium gas is heated to ambient temperature before it passes through the rotameter section. Then, the gas is returned to the inlet of the refrigeration compressor (see Fig. 6).

Gas temperatures at the inlet and outlet to the cryosurface were determined by means of hydrogen vapor pressure thermometers. The thermometer consisted of a small, copper, cylindrical bulb filled with hydrogen immersed in the helium gas stream. Electromanometers were used to measure the hydrogen vapor pressure. The equivalent temperature was determined from temperature versus hydrogen vapor pressure data (Ref. 3). The absolute electromanometers were capable of detecting a pressure change equivalent to 0.01 to 0.04°K, depending on the absolute temperature level. The differential electromanometer could detect a pressure change equivalent to 0.004 to 0.01°K. A calibrated rotameter was used to determine the flow rate of helium to the pumping surface. The accuracy of this measurement was approximately ±3 percent.

3.0 PROCEDURE

The vacuum chamber and test arrays were prepared by leak check procedures developed by the Aerospace Environmental Facility at AEDC.

A chamber pressure rise rate of up to 10^{-3} std cc/sec was considered adequate for these tests, since it produced a negligible condensation heat load on the cryosurface. In conjunction with this leak rate, a system pressure of 10^{-5} to 10^{-6} torr was the upper limit on pressure for the current radiation measurements, since heat transmission by convection is negligible at these pressures. The test arrays system was then cooled down to operating temperatures; this normally took two to three hours. At this point, a radiation power level was set, and the system was allowed to run until a stable heat load was measured on the pumping surface. It was observed that the experimental pumping surface heat load was a function of the refrigerant flow; however, if the flow rate was increased, an operating range was obtained in which the measured heat load was observed to be constant. This operating flow rate range was determined for each configuration, and the flow rate was limited to this interval for each test. The stabilization period required 12 to 15 hours of continuous running. System pressures, temperatures, and radiation levels were recorded continuously during this period. Gases for surface condensates were injected through a gas addition system (Ref. 1).

4.0 RESULTS AND DISCUSSION

The radiation transmission coefficients have been determined experimentally for each array for the two radiation sources, based on incremental changes in pumping surface heat load produced by incremental changes in incident radiation. The load on the pumping surfaces consists of the background load produced by the surrounding surfaces plus the radiation transmitted through the shielding surfaces from the radiation source at a particular power level. Experimentally, transmission coefficients were determined by measuring the total load on the pumping surface for two intensities of incident radiation. The measured increase in pumping surface heat load is the contribution to the total load by the incremental increase in radiation intensity, since the background load remains constant. Consequently, the transmission is defined as the ratio of the incremental change in the heat load of the 20°K cryosurface to the incremental change in the intensity of the incident radiation and is calculated as follows:

$$\text{Transmission Coefficient} = R = \frac{Q_1 - Q_2}{Q_{I_1} - Q_{I_2}}$$

Q_1, Q_2 = 20°K cryosurface heat loads rate for various incident radiation levels

Q = cryosurface heat load rate $= \dot{m}s\,(T_2 - T_1)$

where

$\dot{m}$ = mass flow rate of gaseous helium

s = specific heat of gaseous helium

T_1, T_2 = absolute temperatures at inlet and outlet of 20°K cryosurface

Q_{I_1}, Q_{I_2} = incident radiation loads rate for various power levels

For the blackbody heater,

$$Q_I = \epsilon \sigma T^4$$

where

ϵ = emissivity = 1.0 (assumed)

σ = Boltzmann radiation constant

T = absolute temperature of heater surface

For the Osram-Xenon lamp,

$$Q_I = EW$$

where

E = lamp officiency

W = lamp input

The transmission coefficients for the various arrays and the qualitative effects of shielding array condensates on radiation transmission are presented in the following sections.

4.1 FULL CHEVRON-FLAT PLATE ARRAY

The transmission coefficients, R, for the chevron array (Ref. 4) are presented in Table 1.

TABLE 1

TRANSMISSION COEFFICIENTS, R, FOR THE CHEVRON ARRAY

Array	Radiation Source	Surface of Shielding Array	ΔQ_C	ΔQ_I	R
Chevron	Blackbody Heater	Parson's Black	1.48	270	0.0055
"	"	"	3.16	256	0.012
"	Osram-Xenon Lamp	H_2O Frost on Parson's Black	1.39	540	0.0027
"	"	"	0.90	360	0.0025

The transmission coefficient data for the Osram-Xenon lamp appear to be consistently lower than those for the blackbody heater. Water vapor condensate on Parson's black has an absorptance comparable to that of the undercoat. Therefore, these transmission coefficients should have about the same value. The higher values obtained with Parson's black can be traced back to a defect in the Parson's black coating. An examination of the Parson's black surface indicated that, although virtually all the surface was coated with the black paint, the aluminum base metal was partially visible beneath the coating. This could cause the lowering of the absorptance of the chevron surface and the increase in the transmission coefficient. Figures 9 and 10 show the comparison of the power output of the radiation source and the corresponding heat load on the 20°K cryosurface as a function of time.

The effect of various common condensates on the transmission coefficient is illustrated in Fig. 11. The chevron surface was coated with Parson's black, CO_2 on Parson's black, and water vapor on top of CO_2 condensate already deposited on Parson's black. The approximate values of absorptance for Parson's black, water frost on Parson's black, and carbon dioxide on Parson's black (Ref. 5) are 0.99, 0.95, and 0.8, respectively. An examination of the data in Fig. 11 shows that the heat load on 20°K cryosurface increased with decreasing absorptance of the surface coated, as would be expected. The heat load on the cryosurface with the H_2O - CO_2 condensate should be near the load level for Parson's black coating. It is likely that the inadequate water coating on the CO_2 frost could have resulted in the high heat load level similar to that of CO_2 coated chevron.

The observed trend in heat load level for CO_2 condensates is also illustrated in Fig. 12, using Osram-Xenon lamp as radiation source. When the Osram-Xenon lamp was used, a significant change in the cryosurface heat load was observed for CO_2 frost as compared to comparable data using the blackbody heater. A heat load level of approximately 20 watts was observed with the incident radiation level at one-half the blackbody value for the same heat load value. This can be attributed to the difference in wavelength spectrum between the Osram-Xenon lamp and the blackbody heater. There is very little absorption by CO_2 at wavelengths below 2 microns. The spectrum of the Osram-Xenon lamp is below 2 microns (Fig. 8), and hence, little absorption would be expected. The major portion of the absorption takes place at wavelengths between 2 and 18 microns and is within the wavelength spectrum of the blackbody heater (Fig. 7); consequently, a lower heat load is obtained for a CO_2 condensate.

4.2 HALF CHEVRON-FLAT PLATE

The transmission coefficients, R, for the half chevron array obtained with the blackbody heater and the Osram-Xenon lamp are presented in Table 2.

TABLE 2
TRANSMISSION COEFFICIENTS, R, FOR THE HALF CHEVRON ARRAY

Array	Radiation Source	Surface of Shielding Array	ΔQ_C	ΔQ_I	R
Chevron	Blackbody Heater	Parson's Black	2.25	740	0.0030
"	"	"	2.83	539	0.0053
"	Osram-Xenon Lamp	"	3.56	580	0.0062
"	"	"	1.82	310	0.0059

It appears that the half chevron transmission coefficients are greater in all cases than those of the full chevron. Although these data give transmission coefficients that are larger than those of the full chevron, the values are still very small and are less than 0.62 percent. The experimental data are presented in Figs. 13 and 14 as a plot of cryosurface heat load versus time for various radiation loads. For Parson's black surfaces, the transmission coefficients with Xenon lamp radiation sources appear to be slightly higher than that with blackbody heater.

4.3 CALCULATION OF THE TRANSMISSION OF RADIANT ENERGY THROUGH SHIELDING ARRAYS

A method (Ref. 6) has been suggested for calculating the amount of radiation energy that will be transmitted through the cryosurfaces of various geometries used as shielding surfaces for low temperature pumping surfaces.

The basis for this method is the assumption that radiant energy does exhibit random particle-like behavior, and consequently can be treated in the same manner as molecules in the free-molecule flow region. In view of this, the Monte Carlo technique (Ref. 6), applied formerly to molecular transmission through these arrays, can be applied to radiant energy. From this method, the number of photons reaching the pumping surface and the number of reflections which each of these photons experiences can be calculated. In terms of the emittance of the shielding, the radiation transmission coefficient can be written as follows:

$$R_c = \frac{Q_T}{Q_I} = \left[\frac{(1-\epsilon_a)N_1 + (1-\epsilon_a)^2 N_2 + \cdots + (1-\epsilon_a)^n N_n}{N_T}\right]$$

where

ϵ_a = emittance of shielding array surface

N_n = number of photons making n reflections before striking pumping surface as determined by Monte Carlo technique

n = number of reflections

N_T = total number of incident photons

Q_t = amount of radiation transmitted

Q_I = amount of incident radiation

The radiation transmission coefficients, R_c, for the full chevron and the half chevron are, respectively, 6.17 x 10^{-4} and 16.4 x 10^{-4}. The corresponding experimental values are presented in Sections 4.1 and 4.2. The above values were calculated using a Parson's black emittance of 0.99 and by assuming that all heat reaching the pumping surface is absorbed. The assumption that all heat reaching the pumping surface is absorbed is quite possible since H_2O vapor in the system would condense on the surface and produce on emittance (0.95) very close to that of a blackbody. The calculated transmission coefficients using emittance values as stated are too small by a factor of approximately four. However, if the Parson's black is assumed to be 0.9, the calculated values of transmission coefficient are too high by a factor of approximately 3.0, indicating that an emittance value of around 0.95 would give reasonable agreement. This again is feasible because H_2O vapor normally within the system could possibly produce a surface with an emittance of around 0.95. The transmission coefficient calculated using an emittance of 0.95 for the full chevron and 1.0 for the pumping surface is 35.8 x 10^{-4}, as compared to an experimental value of 26 x 10^{-4}. The corresponding calculated and experimental values for the half chevron are, respectively, 86.8 x 10^{-4} and 61.0 x 10^{-4}. The agreement is quite reasonable in view of the uncertainty of the emittance values and indicates the feasibility of this method for calculating transmission coefficients.

5.0 CONCLUSIONS

The thermal radiation transmitted by two cryoarray configurations has been investigated. It has been shown experimentally that the transmitted radiation is a small fraction of the incident radiation.

The most efficient shielding was produced by the more optically dense arrays. The transmission through the half chevron obtained with the Osram-Xenon source was approximately 2.4 times that of the full chevron. The transmission coefficient for all arrays was less than 0.62 percent.

The increase in radiation throughput by the half chevron, as compared to the full chevron, was appreciably greater than the corresponding increase in pumping speed. Based on the Osram-Xenon lamp data, the half chevron produced an increase in transmitted radiation of 2.4 over that of the full chevron, as compared to an increase in cryopumping speed of 1.6 (Ref. 1).

The feasibility of a method (Ref. 6) for calculating the heat transmission coefficient of these shielding arrays has been satisfactorily demonstrated.

REFERENCES

1. Kirby, W. G. "The Pumping Characteristics of Shielded Low Temperature Surfaces." AEDC-TDR-63-28, March 1963.

2. Unpublished calculations and experimental data of E. Farmer, Jr., Instrumentation Branch, Aerospace Environmental Facility, 1962.

3. National Bureau of Standards. "Table of Thermal Properties of Gases." Circular 564.

4. Moore, R. W., Jr. "Research Study of Cryopumping with a Radiation Shielded Condenser." AEDC-TDR-62-57, March 1962.

5. Cunningham, T. M., Jr., and Young, R. L. "The Radiative Properties of Carbon Dioxide Cryodeposits at 77°K." AEDC-TDR-62-165, December 1962.

6. Pinson, J. D., Capt, and Peck, W. A., 2nd Lt, USAF. "Monte Carlo Analysis of High Speed Pumping Systems." Ninth National Symposium on Vacuum Technology, American Vacuum Society, November 1962.

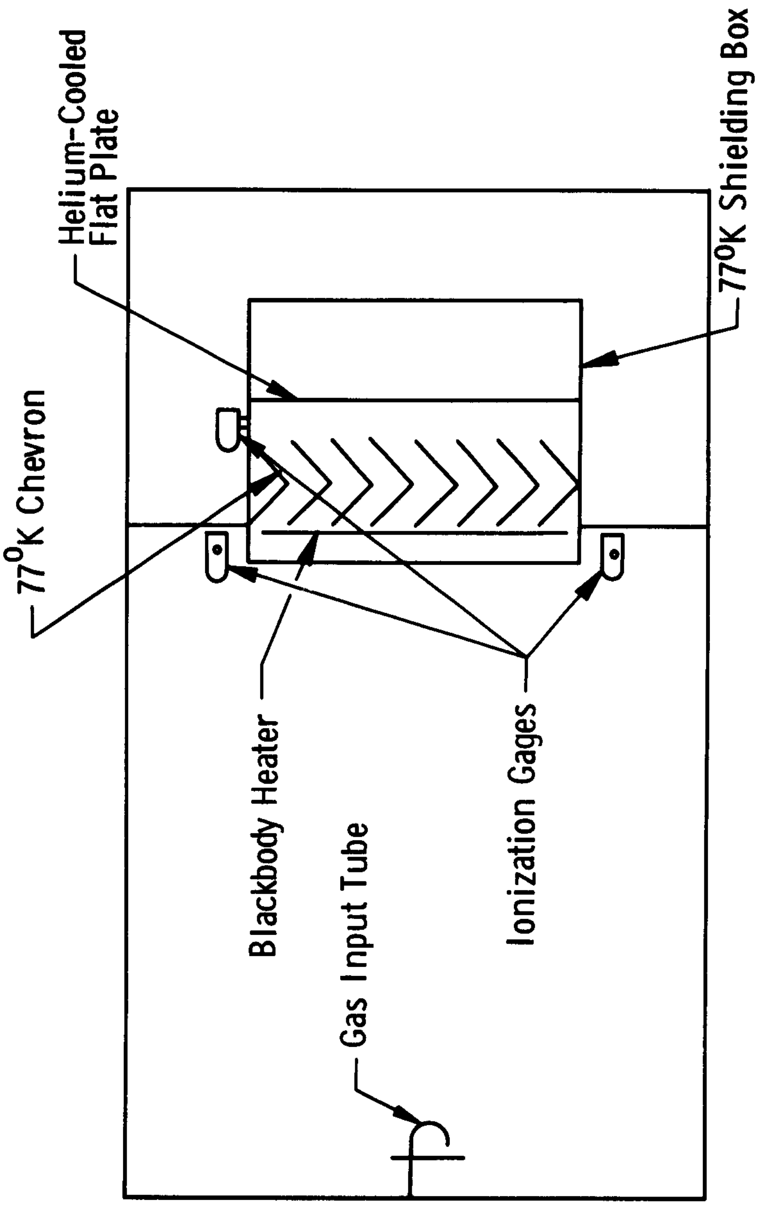


Fig. 1 Full Chevron-Flat Plate Array with Blackbody Heater

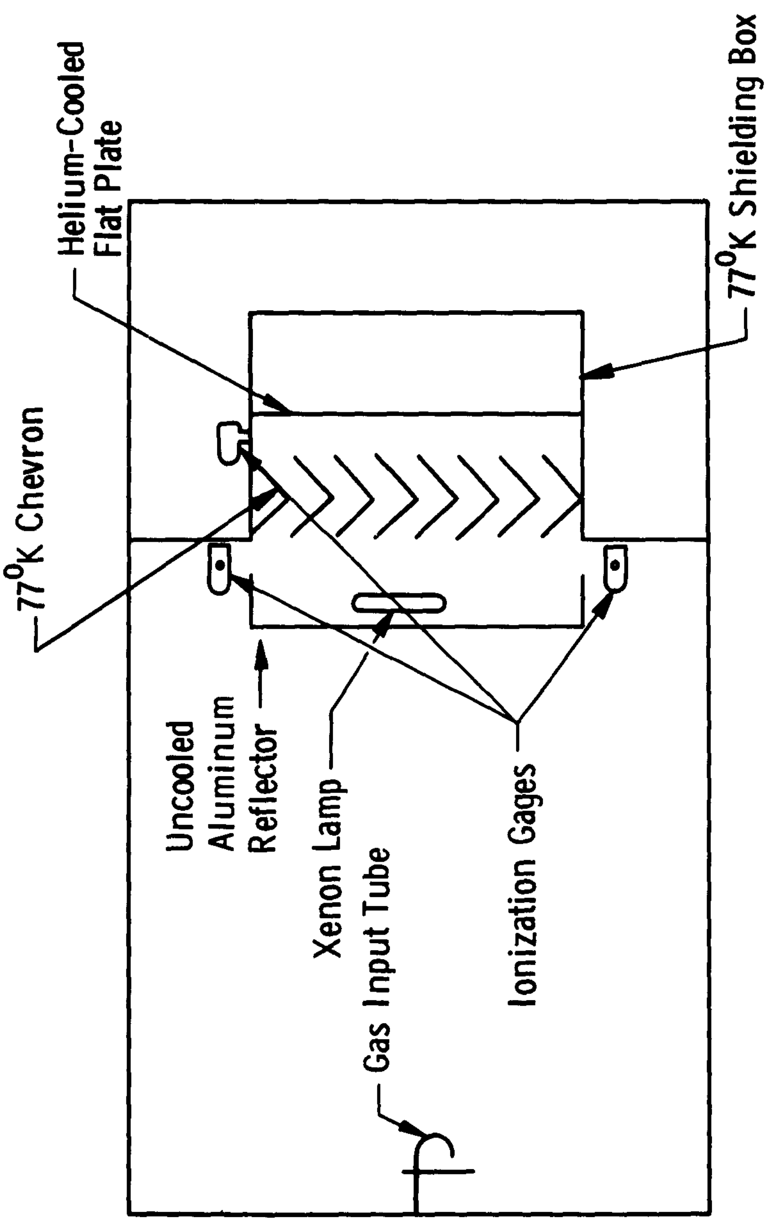


Fig. 2 Full Chevron-Flat Plate Array with Osram-Xenon Lamp

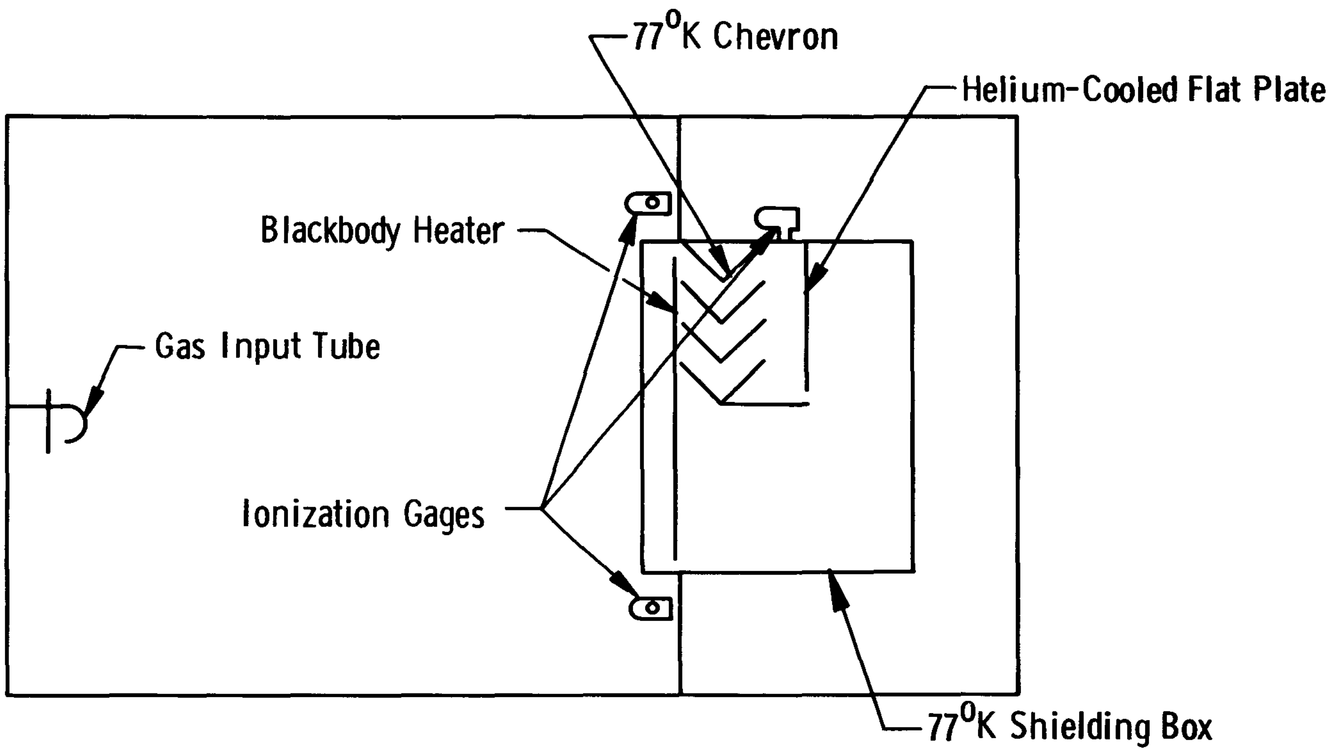


Fig. 3 Half Chevron-Flat Plate Array with Blackbody Heater

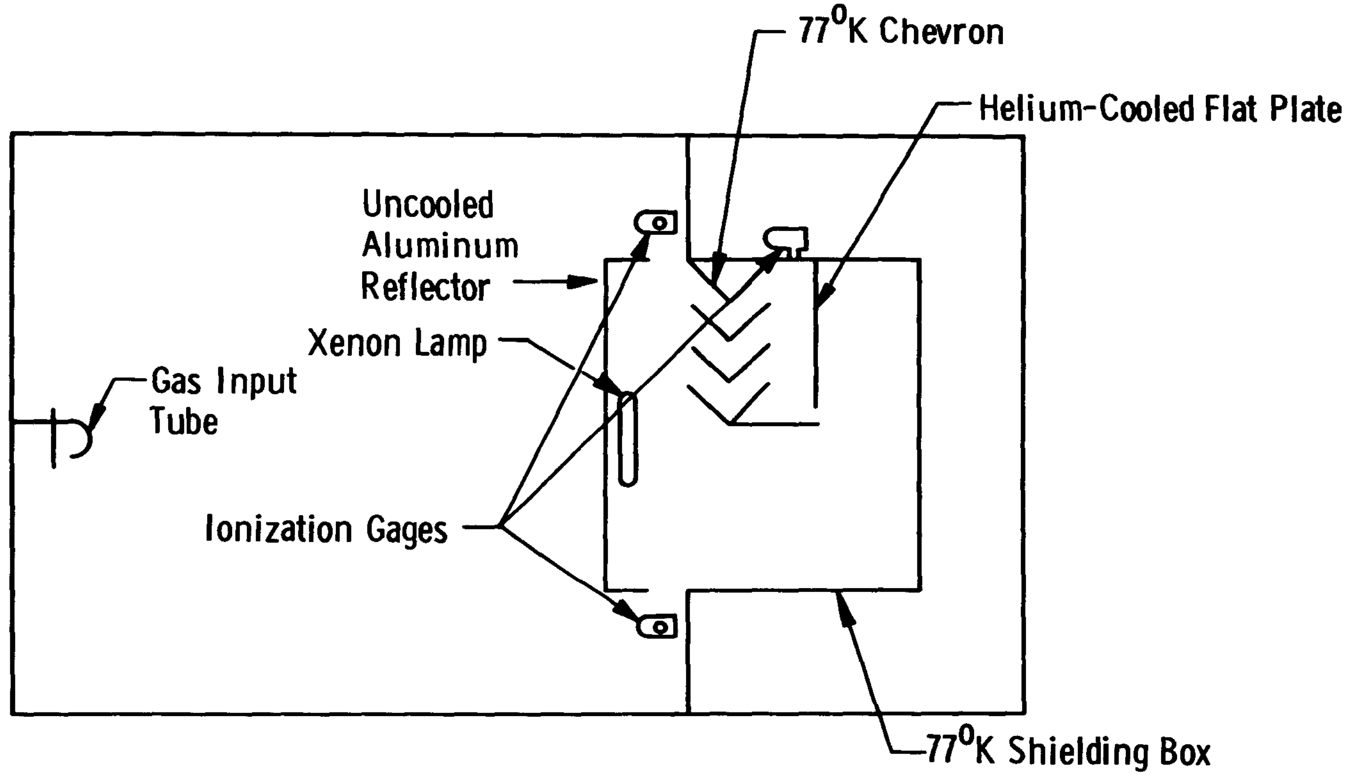
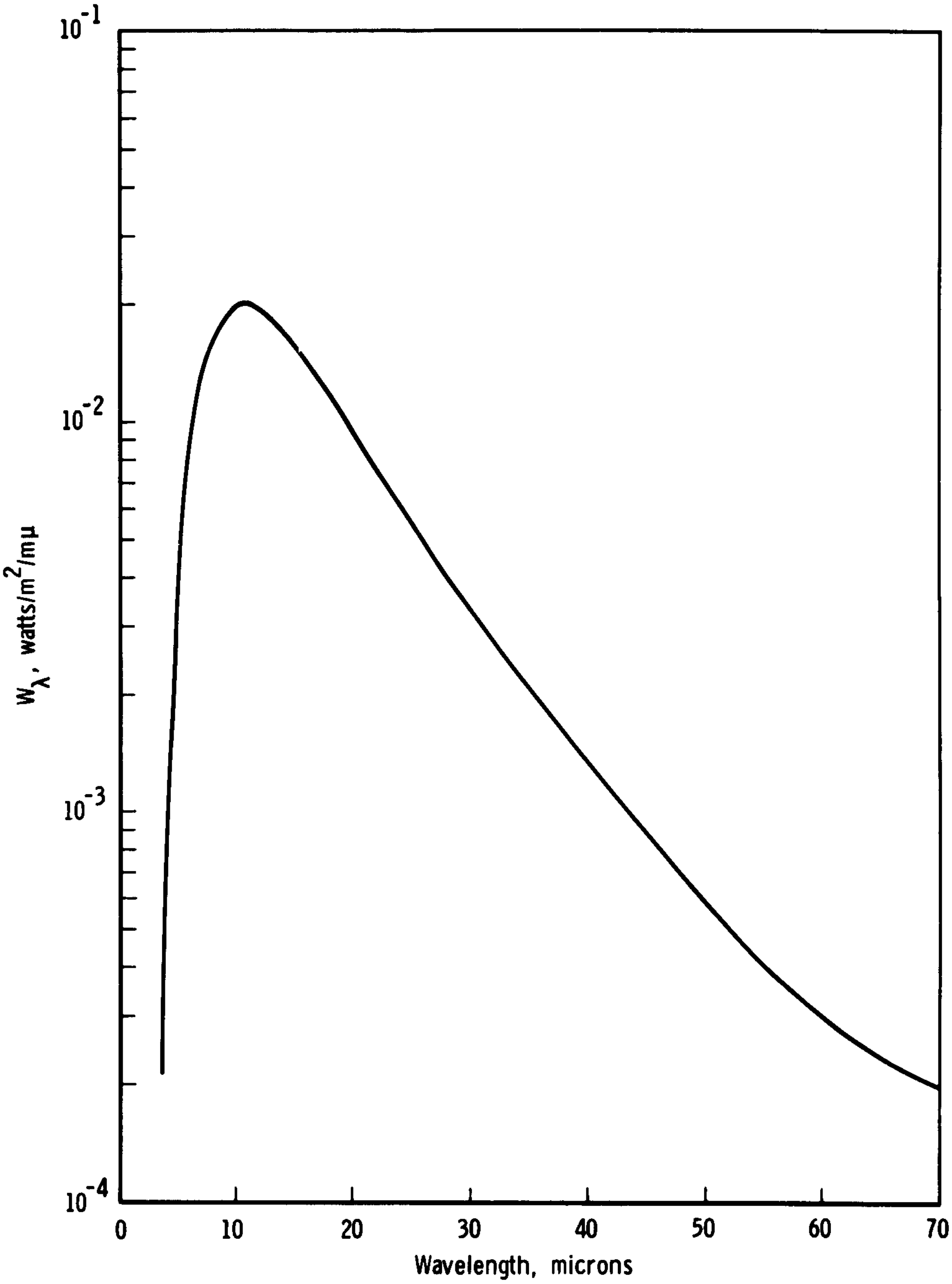
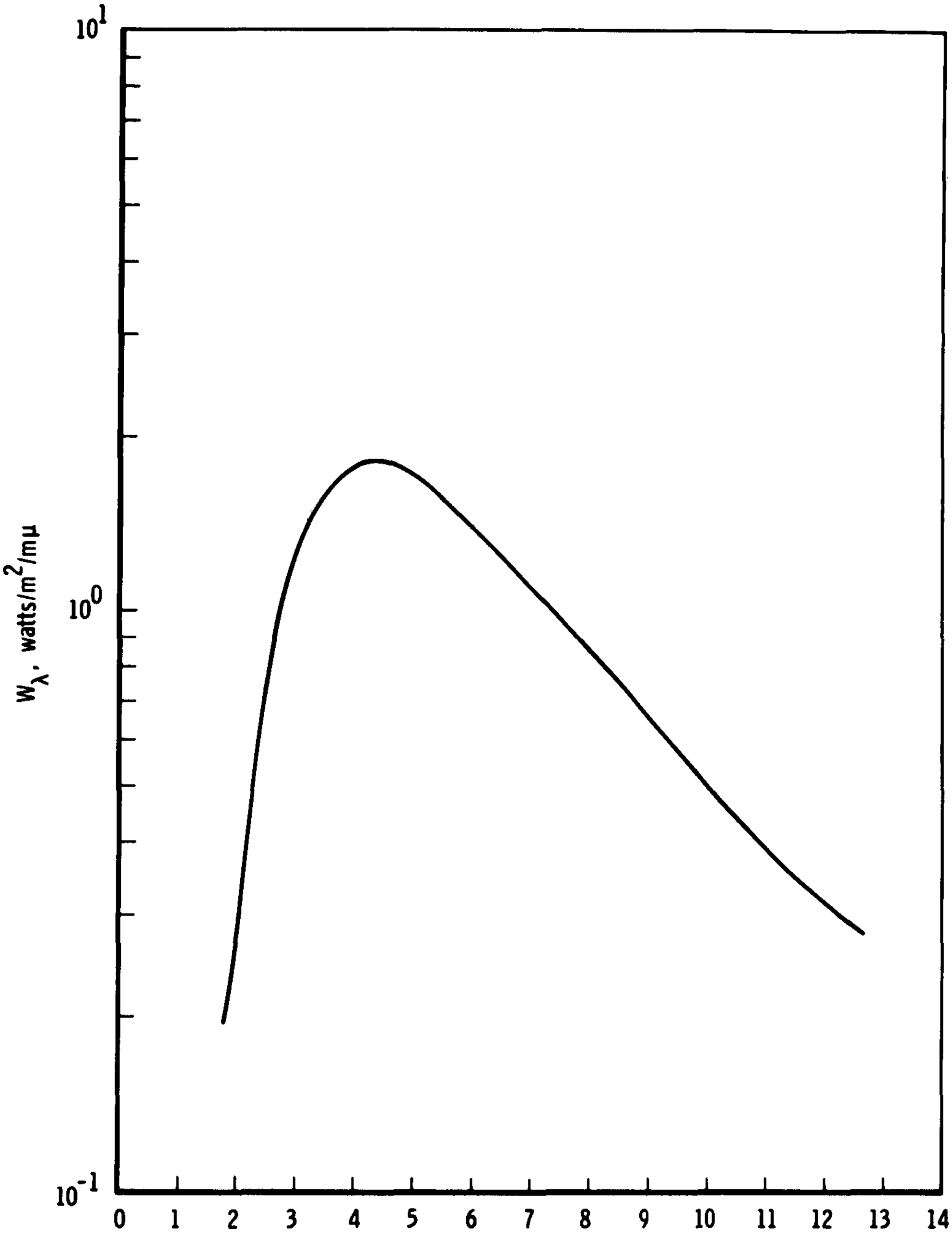


Fig. 4 Half Chevron-Flat Plate Array with Osram-Xenon Lamp



a. Blackbody Temperature = 275°K

Fig. 5 Calculated Spectral Intensity versus Wavelength for Blackbody Heater



b. Blackbody Temperature = 675°K

Fig. 5 Concluded

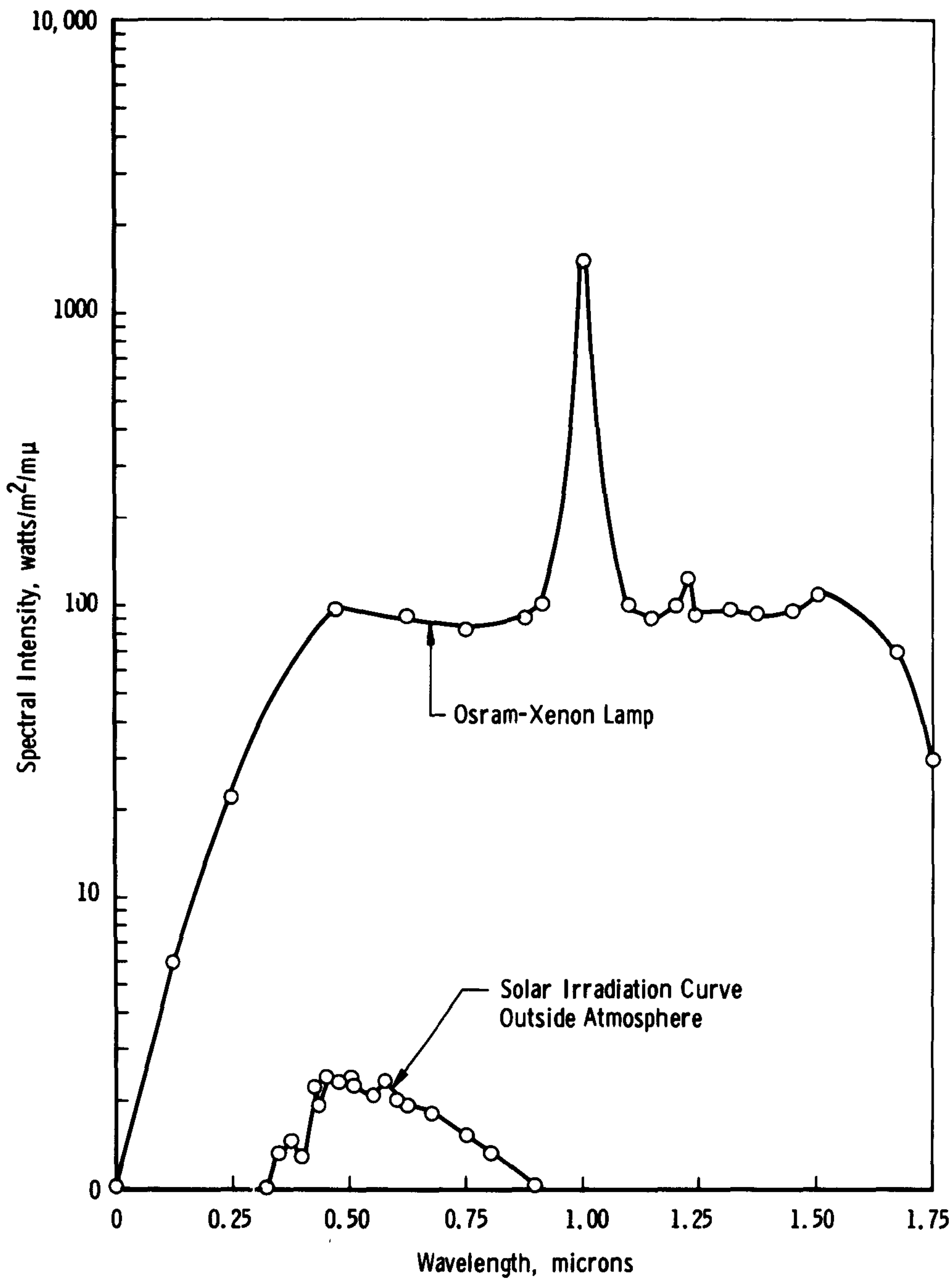


Fig. 6 Spectral Intensity versus Wavelength for Osram-Xenon Lamp

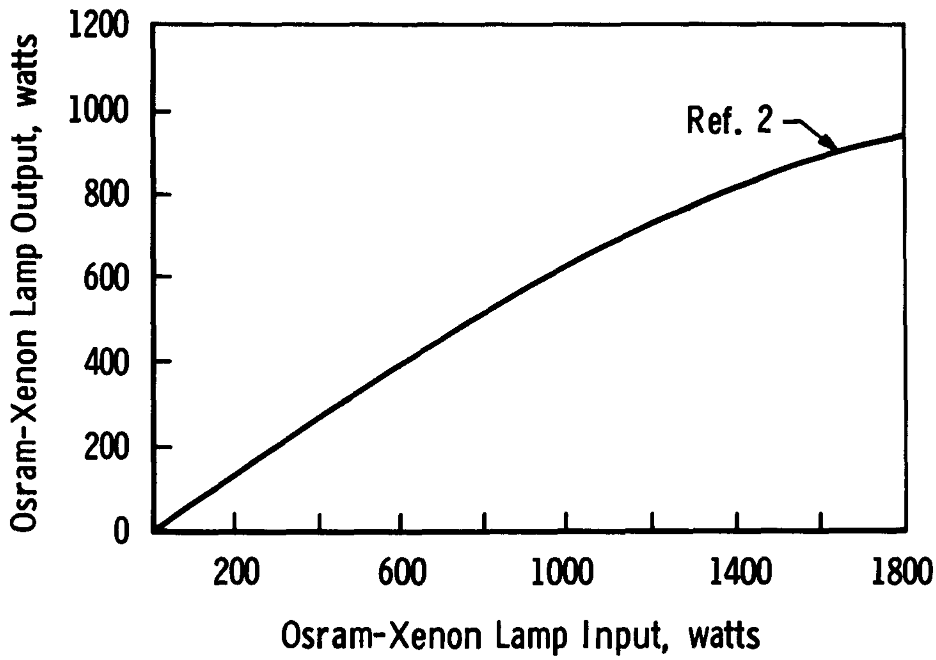
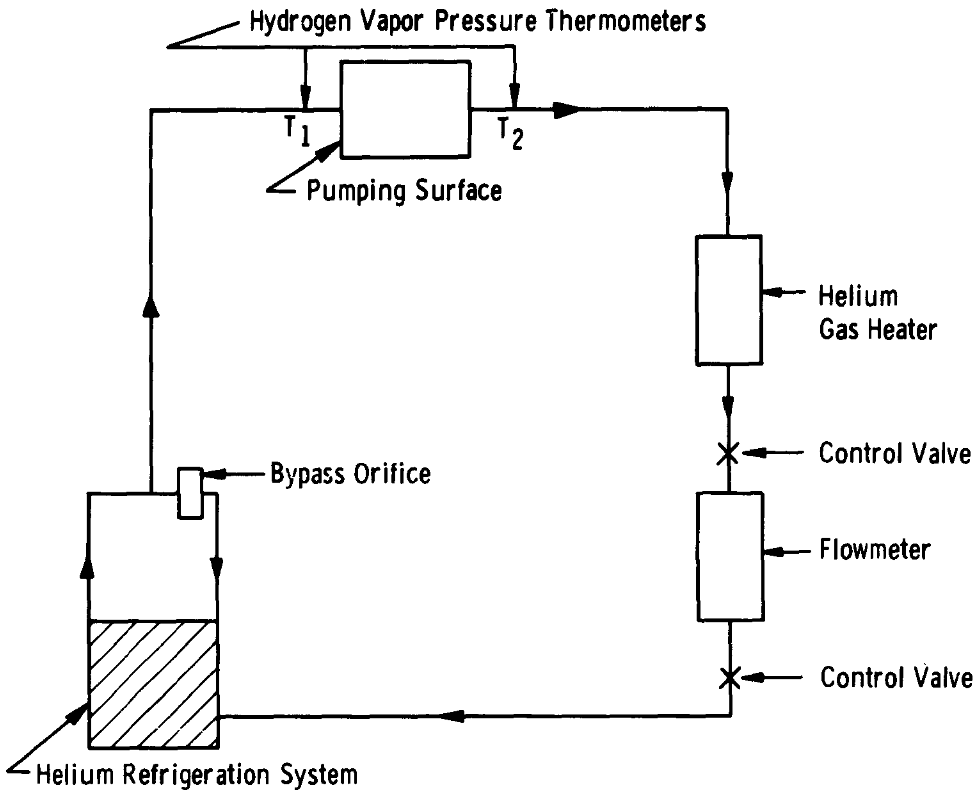


Fig. 7 Efficiency Curve for Osram-Xenon Lamp



Pumping Surface Heat Load $= Q_c = \dot{m}s(T_2 - T_1)$

$\dot{m}$ = Mass Flow Rate
s = Specific Heat for Helium
T_1, T_2 = Absolute Temperature

Fig. 8 Diagram of Pumping Surface Heat Load Measuring System

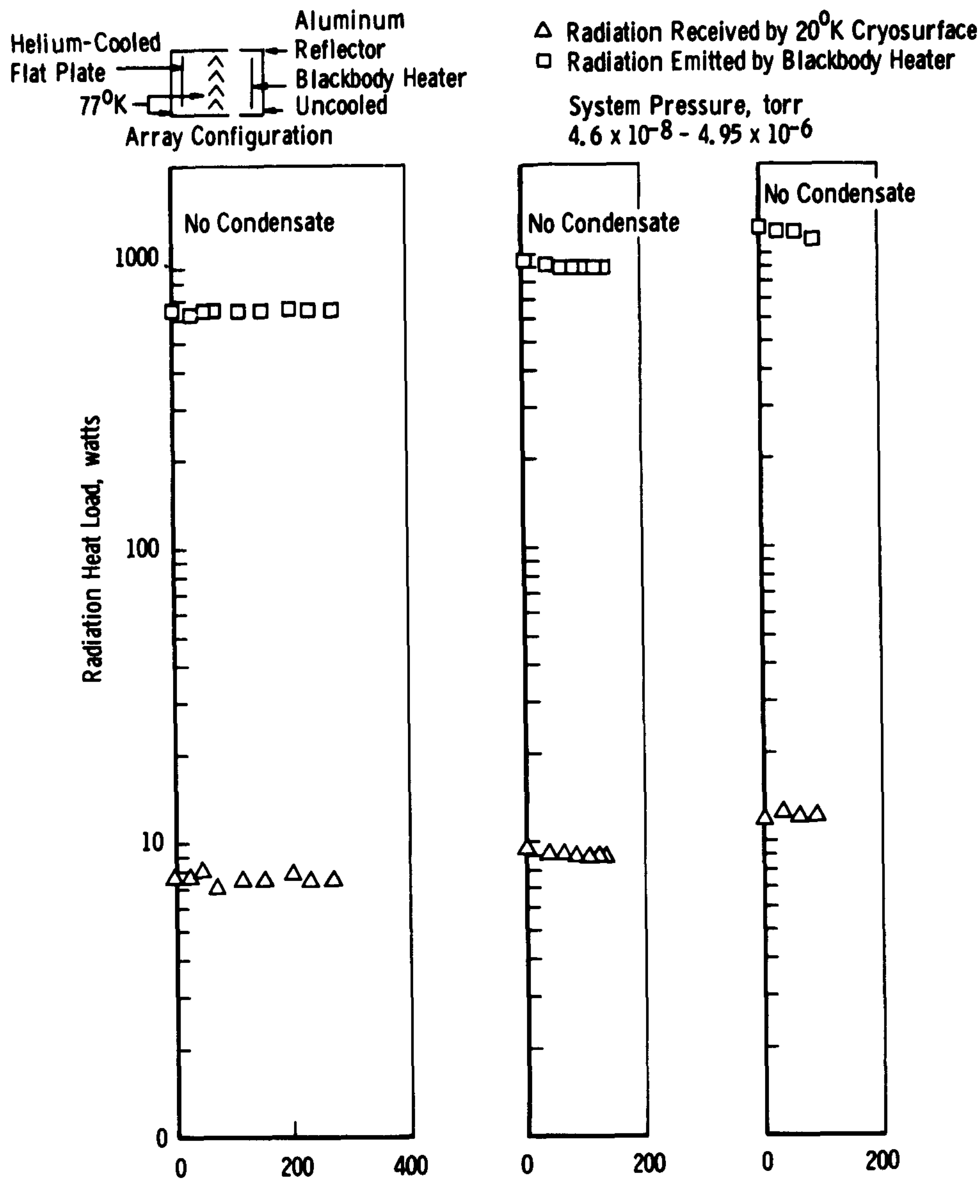


Fig. 9 Radiation Load with Chevron Array and Blackbody Heater for Parson's Black Coating on Shielding Surface

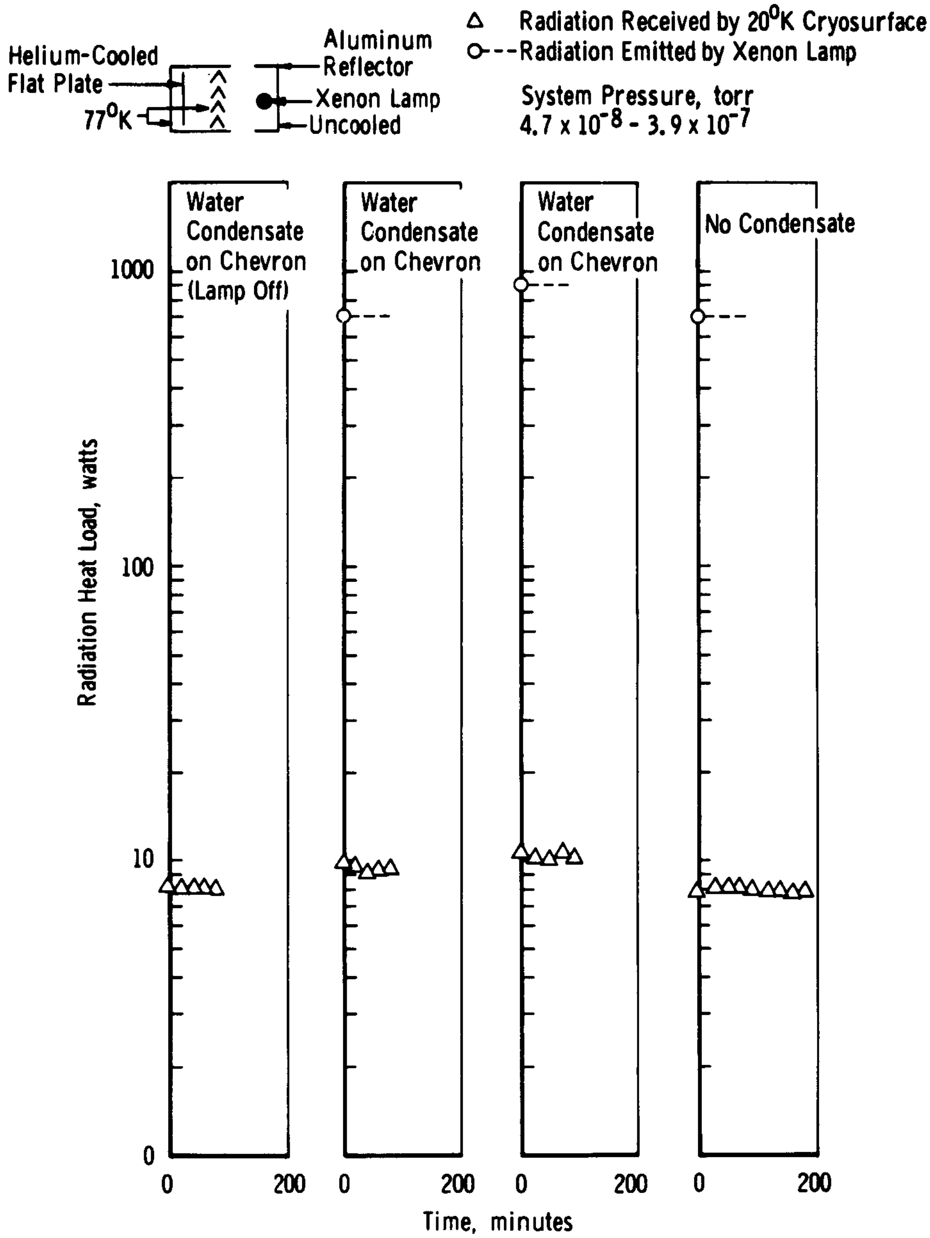


Fig. 10 Radiation Load with Chevron Array and Osram-Xenon Lamp for Water Vapor Coating on Shielding Surface

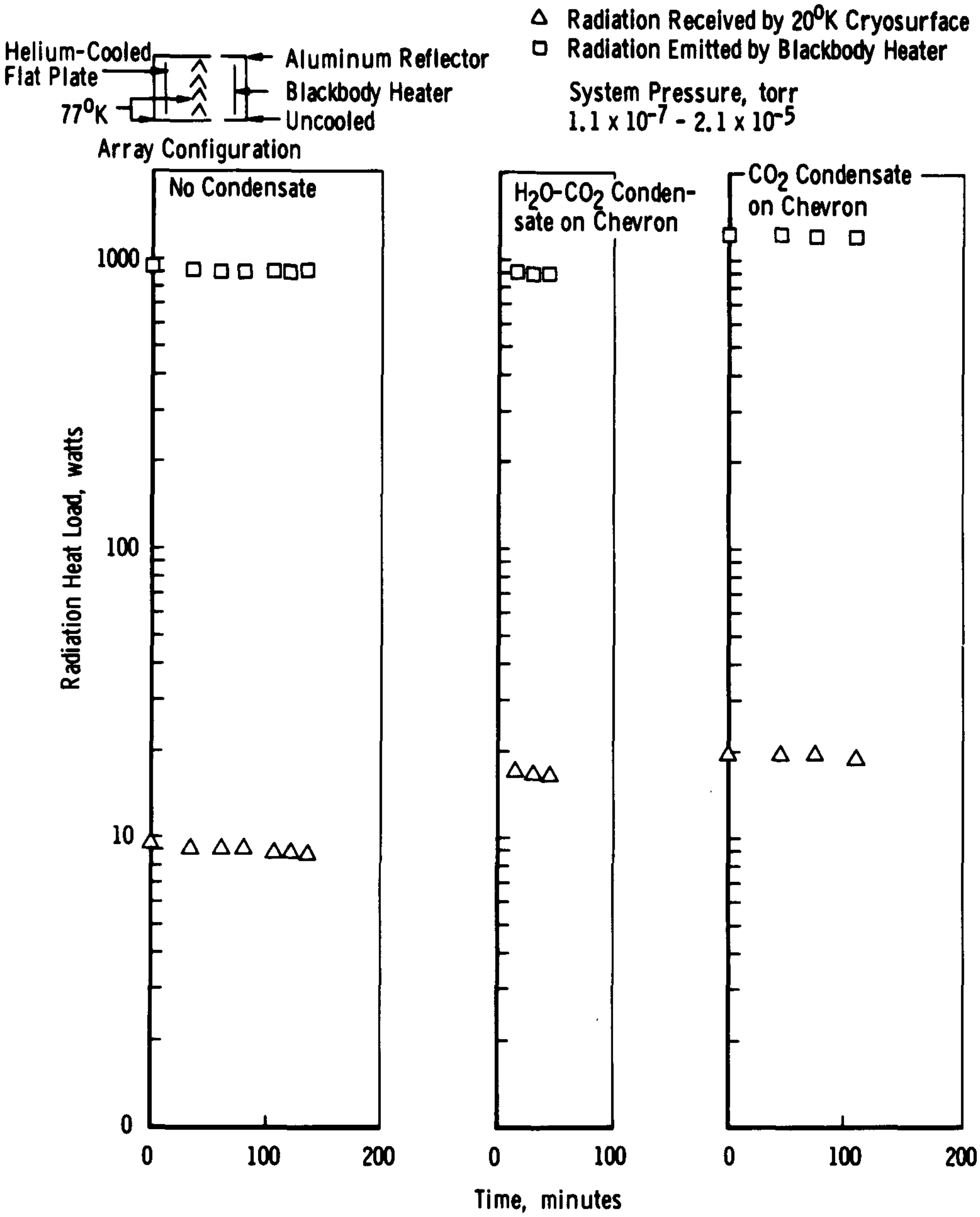


Fig. 11 Radiation Load for Chevron Array and Blackbody Heater with Water Vapor and Carbon Dioxide Coating on Shielding Surface

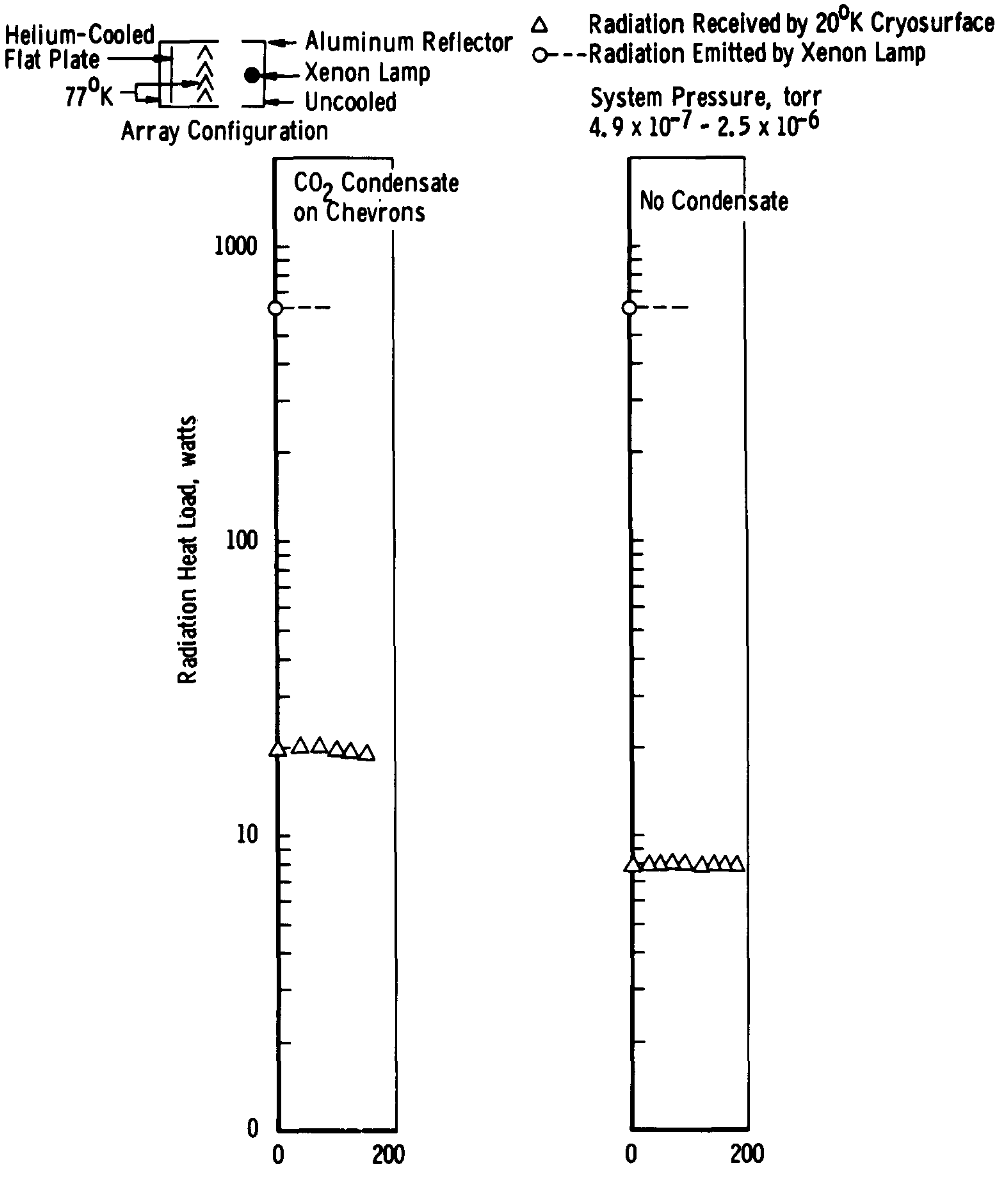


Fig. 12 Radiation Load for Chevron Array and Osram-Xenon Lamp for Carbon Dioxide Coating on Shielding Surface

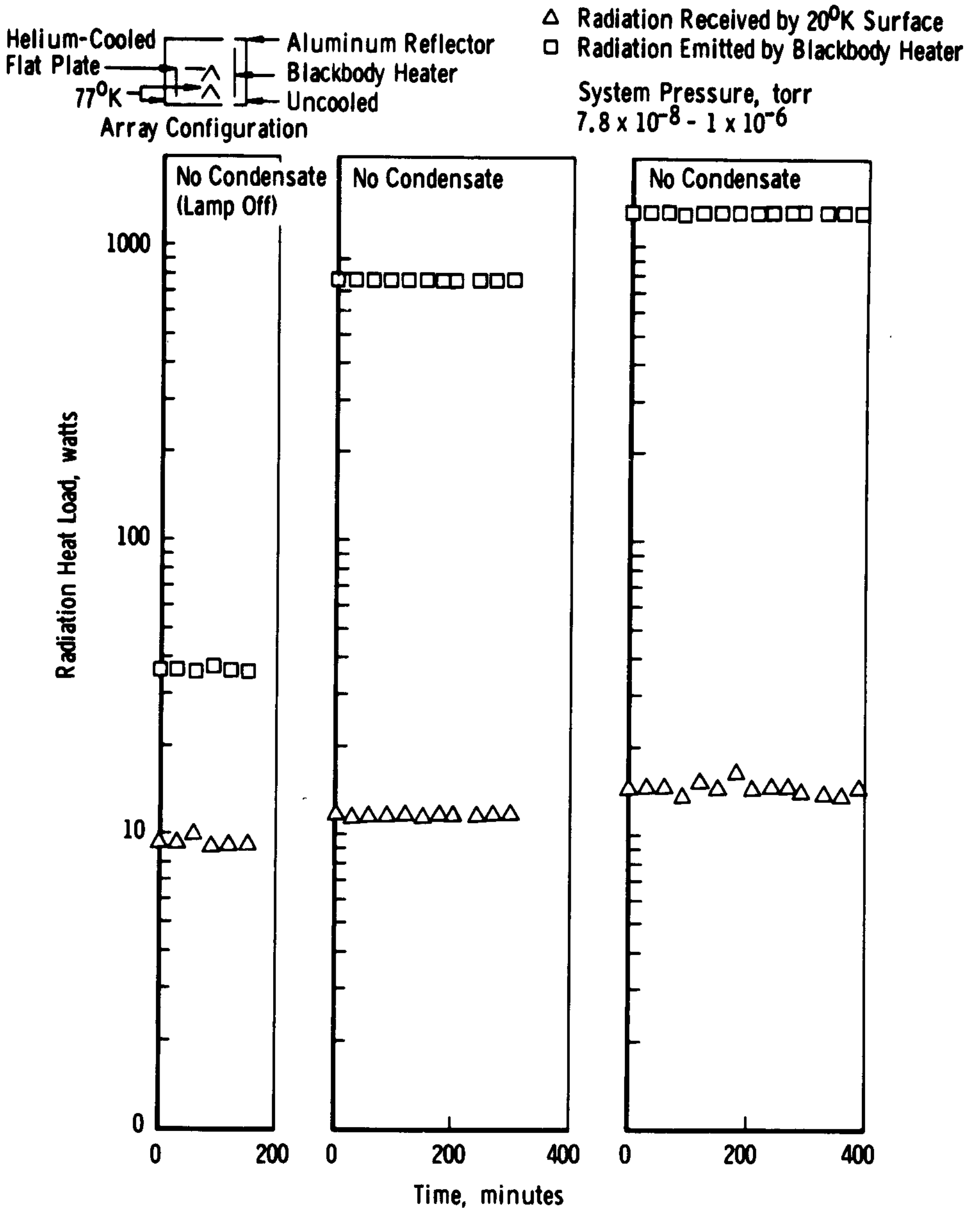


Fig. 13 Radiation Load for Half Chevron Array and Blackbody Heater with Parson's Black Coating on Shielding Surface

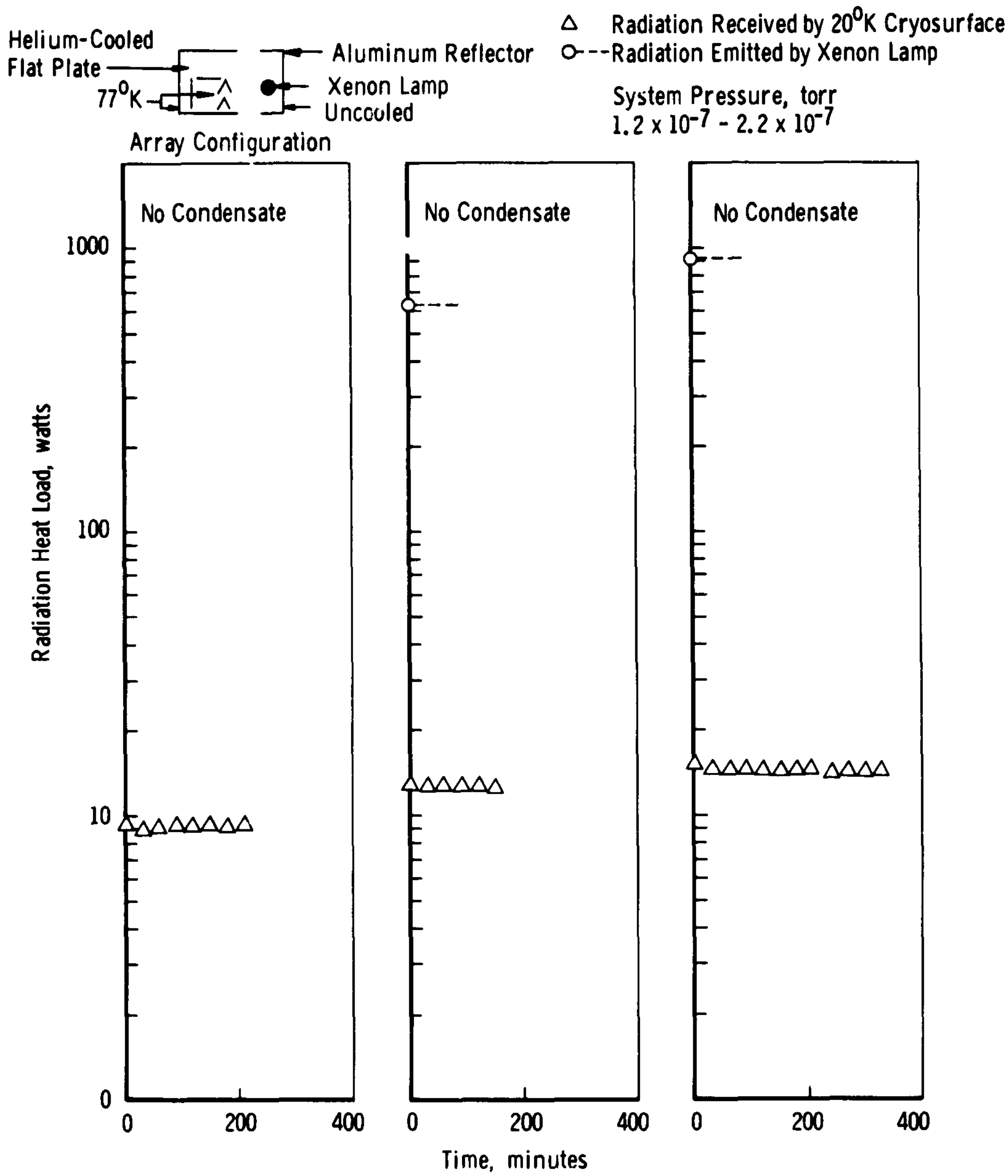


Fig. 14 Radiation Load for Half Chevron Array and Osram-Xenon Lamp with Parson's Black Coating on Shielding Surface

Arnold Engineering Development Center
Arnold Air Force Station, Tennessee
Rpt. No. AEDC-TDR-63-75. RADIATION TRANSMISSION THROUGH SHIELDING ARRAYS FOR LOW TEMPERATURE PUMPING SURFACES. May 1963, 33 p. incl 6 refs., illus., tables.

Unclassified Report

The results of an investigation to determine the amount of thermal radiation transmitted through two cryosurface configurations are presented. The configurations were composed of a 20°K cryosurface enclosed in a 77°K box with a test opening shielded by an optically dense array of 77°K cryosurfaces coated with Parson's black. Radiation at various levels of intensity was applied to the shielding array opening, and the heat load on the 20°K cryosurface imposed by energy transmitted through an array was measured. Heat transmission was also investigated with frost layers deposited over the Parson's black coating on the shielding surfaces.

1. Cryogenics
2. Space environmental conditions
3. Test facilities
4. Thermal radiation
5. Shielding
6. Low-temperature research

I. AFSC Program Area 850E, Project 7778, Task 777800
II. Contract AF 40(600)-1000
III. ARO, Inc., Arnold AF Sta, Tenn.
IV. W. G. Kirby
V. Available from OTS
VI. In ASTIA Collection

Arnold Engineering Development Center
Arnold Air Force Station, Tennessee
Rpt. No. AEDC-TDR-63-75. RADIATION TRANSMISSION THROUGH SHIELDING ARRAYS FOR LOW TEMPERATURE PUMPING SURFACES. May 1963, 33 p. incl 6 refs., illus., tables.

Unclassified Report

The results of an investigation to determine the amount of thermal radiation transmitted through two cryosurface configurations are presented. The configurations were composed of a 20°K cryosurface enclosed in a 77°K box with a test opening shielded by an optically dense array of 77°K cryosurfaces coated with Parson's black. Radiation at various levels of intensity was applied to the shielding array opening, and the heat load on the 20°K cryosurface imposed by energy transmitted through an array was measured. Heat transmission was also investigated with frost layers deposited over the Parson's black coating on the shielding surfaces.

1. Cryogenics
2. Space environmental conditions
3. Test facilities
4. Thermal radiation
5. Shielding
6. Low-temperature research

I. AFSC Program Area 850E, Project 7778, Task 777800
II. Contract AF 40(600)-1000
III. ARO, Inc., Arnold AF Sta, Tenn.
IV. W. G. Kirby
V. Available from OTS
VI. In ASTIA Collection